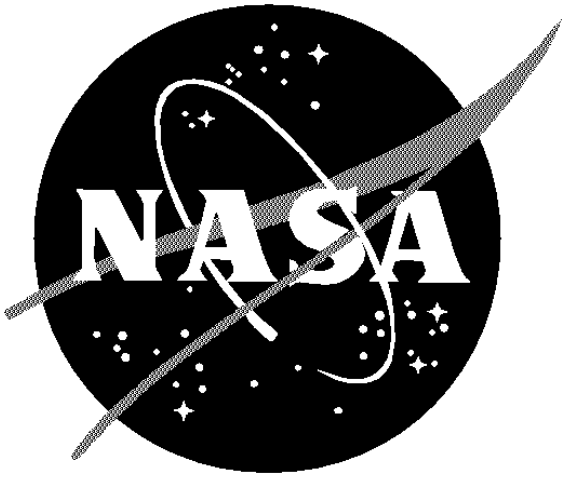

National Aeronautics and Space Administration

April 2, 1999

NRA-99-OES-01

RESEARCH ANNOUNCEMENT

OPPORTUNITIES TO PARTICIPATE IN NEW MILLENNIUM PROGRAM EARTH OBSERVING-1 MISSION INSTRUMENT PERFORMANCE EVALUATION AND DATA VALIDATION

Proposals Due – June 17, 1999

OMB Approval No. 2700-0087

OPPORTUNITIES TO PARTICIPATE IN NEW MILLENNIUM PROGRAM EARTH OBSERVING-1 MISSION INSTRUMENT PERFORMANCE EVALUATION AND DATA VALIDATION

NASA Research Announcement
Soliciting Research Proposals
for
Period Ending
June 17, 1999

NRA-99-OES-01
Issued April 2, 1999

Office of Earth Science
National Aeronautics and Space Administration
Washington, DC 20546

NEW MILLENNIUM PROGRAM EARTH OBSERVING-1 MISSION INSTRUMENT PERFORMANCE EVALUATION AND DATA VALIDATION

I. PURPOSE OF THIS NASA RESEARCH ANNOUNCEMENT

The National Aeronautics and Space Administration (NASA) and the U.S. Geological Survey (USGS) of the Department of the Interior (DOI) announce the joint solicitation of proposals for scientific investigations to validate the NASA New Millennium Program's (NMP) Earth Observing-1 (EO-1) mission technologies and to assess EO-1 spectral imaging for science and applications research. Proposals to address the following objectives are solicited: 1) to evaluate the selected EO-1 technologies with respect to their ability to meet the needs for future Landsat-class observations at reduced cost and with enhanced quality, 2) to evaluate space-based imaging spectrometers for potential future NASA and USGS scientific, applied, and commercial uses of hyperspectral data, and 3) to evaluate the implications for data correction and calibration of new ways of conducting missions such as: formation flying with other satellites, approaches to inter-satellite and lunar calibration and atmospheric correction, and autonomous navigation/instrument operation. This NMP EO-1 Instrument Performance Evaluation and Data Validation Program will be referred to hereafter in this NASA Research Announcement (NRA) as the "EO-1 Validation Program."

In addition to offering funding opportunities for EO-1 validation research, NASA and USGS are encouraging proposals that can offer significant cost sharing in exchange for participation on the EO-1 Validation Team and access to EO-1 data, including opportunities to request specific satellite data acquisitions, consistent with the objectives of this NRA.

II. BACKGROUND

A. NASA's Earth Science Enterprise

NASA's Earth Science Enterprise (ESE) is studying how our global environment is changing. ESE's near-term focus is on understanding the Earth as an integrated system, including the effects and couplings of the solid Earth, land surface, oceans, ice, atmosphere, and biota. In support of research goals of the U.S. Global Change Research Program and of other national and international research programs, NASA has established the following Earth System Science research themes: land-cover and land-use change, seasonal-to-interannual climate variability and prediction, long-term climate: natural variability and change, atmospheric ozone, and natural hazards research and applications. Using the unique perspective available from space, NASA observes, monitors, and assesses large-scale environmental processes. ESE satellite data, complemented by aircraft and ground data, process studies, and modeling, are enabling us to better understand environmental changes, to determine how human activities have contributed to these changes, and to understand the consequences of such changes. ESE science also gives rise to a host of practical applications designed in part or in whole by commercial firms and state and

local governments. ESE data and information, which NASA distributes to researchers worldwide, and the results of ESE science and applications research provide an objective starting point for the development of sound global environmental policy. More information on NASA's ESE can be found at: http://www.earth.nasa.gov/

B. USGS Science Programs

The USGS provides the Nation with reliable, impartial information to aid in describing and understanding the Earth and its resources. As the lead earth and biological science bureau for the DOI, and as DOI's focal point for remote sensing policy, research, and coordination, the USGS plays an active role in fostering research in new satellite land remote sensing technologies and applications. As a partner with NASA in managing the Landsat 7 program, the USGS intends to assume end-to-end operational responsibility for the program by 2001. The USGS Earth Resources Observation Systems (EROS) Data Center (EDC) operates the Landsat 7 ground processing system and short-term data archive. The Center also manages the National Satellite Land Remote Sensing Data Archive, which contains historical Landsat and other satellite data sets, and the Land Processes Distributed Active Archive Center (DAAC), which is one of six primary data centers for NASA's EOSDIS program.

The USGS has a number of science initiatives focused on improving our understanding of the Earth's crust, including the processes that control the occurrence of its non-renewable natural resources, the impacts of natural hazards on society, the patterns and dynamics of land use and land cover and the corresponding local to global impacts, the spread of invasive plant and animal species, biodiversity assessments and conservation planning, and regional to national assessments of water quality. USGS remote sensing programs include research on geometric and radiometric processing, algorithm development and state-of-the-art strategies for new product generation, and data distribution systems. The USGS uses data collection strategies ranging from *in situ* measurements to satellite observations to provide information on the processes, characteristics, conditions, and trends affecting land use and land cover, terrestrial and aquatic flora and fauna, water resources quality and quantity, and geological resources. Increasing emphasis is also being placed on the use of synoptic monitoring strategies that link the extensive USGS *in situ* data collection programs and provide spatially explicit information on the status and trends of national land and water resources. Information on USGS science programs can be found at: http://www.usgs.gov/

C. NASA New Millennium Program

NASA has an ambitious plan for space exploration in the next century. It envisions a scenario in which spacecraft will have revolutionary new capabilities compared to those of today. Spacecraft are envisioned as flying in formation, or in fleets, or having artificial intelligence to provide the kind of capability that can answer the more detailed level of questions that scientists have about the universe. NASA created the New Millennium Program (NMP) to identify and test advanced technologies that will provide spacecraft with the capabilities they need in order to achieve this vision. Advanced technologies promise a great leap forward in terms of future spacecraft capability, but they also present a risk to missions that use them for the first time. Through a series of deep space and Earth orbiting flights, NMP will demonstrate promising but risky

technologies in space to “validate” them, that is, to prove that they work. Once validated, these technologies will pose risk levels more acceptable to missions that would like to use them to achieve their scientific objectives. Technologies validated under NMP also provide the substantial benefits to future missions of reduced cost and availability for science use within the new ESE goal of no more than three years from mission commitment to launch. While each NMP flight will carry a suite of advanced technologies to be tested in space, missions also will be capable of accomplishing scientific objectives. Science data will be returned during the various flights as the advanced technologies are "put through their paces," thus accomplishing dual goals for the program in both technology and science. In this way, NMP missions also offer the promise of returning exciting new scientific information for scientists and the public. More information on NASA’s NMP can be found at: http://nmp.jpl.nasa.gov/

D. Earth Observing-1

The Earth Observing-1 (EO-1) mission is the first in the NMP’s series of Earth orbiting flights. It is an advanced land imaging mission that will demonstrate new instruments and spacecraft systems with a focus on validating revolutionary technologies contributing to the reduction in cost and increased capabilities for future land imaging missions. Three advanced land imaging instruments on EO-1 will collect multispectral and hyperspectral data over the course of its mission. Breakthrough technologies in lightweight materials, high performance integrated detector arrays and precision spectrometers will be demonstrated in these instruments. The EO-1 mission also will provide the on-orbit demonstration and validation of several spacecraft technologies to enable a future transition to smaller and lighter NASA spacecraft. Key technology advances in communications, power, propulsion, thermal control, and data storage are included on the EO-1 mission. EO-1 is scheduled for launch in December, 1999.

The primary goal for the EO-1 mission is to demonstrate advanced technology to enhance the capabilities and reduce the cost of obtaining Landsat-like data in the future. One of the key responsibilities of NASA’s ESE is to ensure the continuity of a Landsat-class data stream into the future. Since 1972, the Landsat series of satellites has been producing seasonal, multispectral images of the land area of the Earth. These images are used for environmental, agricultural, geological, hydrological, urban and global change research applications. The Multispectral Scanner Systems (MSS) on Landsats 1-3 were followed by the Thematic Mapper (TM) instruments on Landsats 4-5, and the soon to be launched Enhanced Thematic Mapper Plus (ETM+) on Landsat 7. This sequence of increasingly more capable multispectral imaging instruments allowed Landsat to change and take advantage of technological advances while still maintaining the continuity of the data stream. The EO-1 mission will help us prepare for incorporating more revolutionary advances into post-Landsat 7 missions. EO-1 is planned to fly during the first years of the Landsat 7 mission. To support technology validation, the orbit of EO-1 will match within one minute the Landsat 7 ground track so that both instruments will be able to collect near simultaneous images of the same location. EO-1 operations will be planned to coordinate data collections with Landsat 7 in order to facilitate comparisons between the two instruments and their data products.

Another important goal for EO-1 is to demonstrate imaging spectrometer instrument technology and explore Earth science applications of hyperspectral data that relate to future ESE

requirements. NASA had planned to provide a technology demonstration for imaging spectrometer instrumentation and exploration of hyperspectral science, commercial, and educational applications through the Lewis mission under the Small Satellite Technology Initiative (SSTI). This opportunity was lost with the loss of the satellite in September, 1997, shortly after launch. The hyperspectral imaging spectrometers to fly on EO-1 will allow NASA to recover and expand this opportunity, albeit in the context of a mission with somewhat different objectives. EO-1 will be in orbit contemporaneously with at least two other hyperspectral imagers, i.e., the U. S. Navy's Naval EarthMap Observer (NEMO) and the U. S. Air Force's Warfighter-1, and there may be opportunities for intercomparison with data from these satellite missions as well.

III. EO-1 MISSION

The EO-1 mission has four overall objectives that are consistent with the major ESE NMP goal of reducing costs and expanding the capability of future land observation missions. The first objective is to evaluate selected technologies in the context of meeting science needs in the twenty-first century for continuing Landsat-class observations at reduced cost and with enhanced capability. Secondly, NASA will evaluate space-based imaging spectrometers for potential future ESE scientific, applied, and commercial uses. Thirdly, NASA will use EO-1 to evaluate new ways of conducting missions in the twenty-first century. This includes formation flying with other satellites, approaches to inter-satellite and lunar calibration, and autonomous navigation/instrument operation. A fourth objective is to use the EO-1 mission to provide a technology infusion path for future NASA and other government agency satellite missions. The EO-1 Validation Program will focus on the first three EO-1 mission objectives, in order of priority as listed above. The instruments on EO-1 to be evaluated are: 1) the Advanced Land Imager (ALI), 2) Hyperion, and 3) the Linear Etalon Imaging Spectral Array (LEISA) Atmospheric Corrector (LAC).

A. Advanced Land Imager (ALI)

The Advanced Land Imager (ALI) instrument is intended to provide a development path for future Landsat-type instrument technology. The EO-1 implementation of ALI consists of a 15° Wide Field Telescope (WFT) and partially populated focal plane occupying one fifth of the field-of-view (37 km ground swath). It has nine multispectral (MS) bands with 30 m spatial resolution and one 10 m panchromatic (Pan) band. A full-up version of this instrument is projected to have one quarter the mass, one fifth the power consumption, and one seventh the instrument volume of the Landsat 7 ETM+ instrument while providing improved performance. The ALI does not, however, include a thermal infrared band. The overall objective of the ALI validation is to assess the capability of ALI to produce calibrated, multispectral images of the land area of the Earth.

B. Hyperion

The Hyperion hyperspectral imager is a pathfinder to benchmark the potential of space-based imaging spectrometers for Earth observation applications, both for direct hyperspectral data

analysis and as a flexible means for creating Landsat-equivalent multispectral data sets. The instrument is a 220-channel imager with 10 nm wide contiguous bands and a swath width of 7.5 km. Its spatial resolution of 30 m matches that of Landsat. Its spectral coverage from 400-2500 nm will allow investigators to address a broad range of Earth science research and applied uses. Relatively detailed atmospheric analysis using Hyperion will allow cross calibration with LAC. Synthesis of Landsat bands using data from an imaging spectrometer may provide increased flexibility for future missions, enabling both hyperspectral science and applications as well as Landsat-class data continuity. Hyperion will allow us to explore software approaches to Landsat band synthesis.

C. Linear Etalon Imaging Spectral Array (LEISA) Atmospheric Corrector (LAC)

An ability to accurately correct images for atmospheric conditions is required to exploit fully the better calibrated, higher signal-to-noise, and greater spatial resolution surface measurements of future space-borne instruments. A wedge spectral imaging system is included in the EO-1 manifest to provide atmospheric water vapor and thin cirrus extinction correction to the imaging data collected by both the ALI and the co-orbiting Landsat 7 ETM+ instrument. This Linear Etalon Imaging Spectral Array (LEISA) Atmospheric Corrector (LAC) is a high-spectral resolution system with variable resolution (e.g., 35 cm^{-1} or 3.5 nm at 1000 nm wavelength) and a spectral range of 890-1600 nm. LAC has 250 m spatial resolution and a full 185 km Landsat swath width.

D. EO-1 Mission Operations

EO-1 will fly in a 705 km circular, sun-synchronous orbit at a 98.7 degree inclination. This orbit allows EO-1 to match within one minute the Landsat 7 ground track and collect identical images for later comparison on the ground. Once or twice a day, sometimes more, both Landsat 7 and EO-1 will image the same ground areas (scenes). All three of the EO-1 land imaging instruments will view all or sub-segments of the Landsat 7 swath. For each data acquisition, to be called a data collection event (DCE), over 20 Gbits of scene data from the ALI, Hyperion, and LAC will be collected simultaneously and stored in the on-board solid state data recorder at high rates. When the EO-1 spacecraft is in range of a ground station, the spacecraft will automatically transmit its recorded data to the ground station for temporary storage and shipment to the Goddard Space Flight Center (GSFC). The planned mission lifetime is 1 year.

The particular scenes that EO-1 will acquire for ALI, Hyperion, and LAC will be selected based on the needs of successful proposers, the NASA EO-1 Program and Project Offices, USGS, and other partners in satellite hyperspectral data validation. It is anticipated that the integrated mission acquisition requirements will allow for an acquisition strategy that includes: 1) sufficient scenes to ensure the availability of at least 200 scenes for MS/Pan comparisons against Landsat 7 ETM+ and 200 scenes for Hyperion validation for an appropriate variety of ground target, atmospheric, and instrument conditions; 2) scenes over well characterized test sites (e.g. EOS or other hyperspectral sensor calibration and validation sites); 3) acquisition of some long (i.e. >400 km) transects of data; and 4) acquisition of scenes in areas of active regional field studies.

More information on NASA's EO-1 mission, including publications, can be found in at: http://eo1.gsfc.nasa.gov/. Detailed instrument descriptions are provided in Appendix A.

IV. TYPES OF PROPOSALS REQUESTED FOR EO-1 VALIDATION PROGRAM

The objectives for this announcement, listed in decreasing order of priority, are:

To evaluate the selected EO-1 technologies with respect to their ability to meet the needs for future Landsat-class observations at reduced cost and with enhanced quality (hereafter referred to as "Landsat Data Continuity")

To evaluate space-based imaging spectrometers for potential future scientific and applied uses (hereafter referred to as "Hyperspectral Applications")

To evaluate new ways of conducting missions such as formation flying with other satellites, approaches to inter-satellite and lunar calibration, and autonomous navigation/instrument operation; emphasis for the EO-1 Validation Program under this objective will be on implications for calibration of the data (hereafter referred to as "Calibration")

Meeting these objectives will be furthered by close coordination with Landsat research and validation activities (see http://geo.arc.nasa.gov/sge/landsat/landsat.html). EOS Terra, NEMO, and Warfighter-1 research and validation activities also may offer valuable opportunities for collaboration and coordination of activities. The ability of EO-1 to make Landsat-like measurements will need to be evaluated against the performance of past Landsat sensors as well as directly against concurrent Landsat 7 ETM+ measurements. Proposers to the EO-1 Validation Program should consider seeking opportunities to participate in Landsat, EOS Terra, NEMO, or Warfighter validation activities by proposing to acquire data, as appropriate, over established test sites for these sensors and/or by developing, as opportunities become available, other forms of collaboration with these programs.

A. Landsat Data Continuity

Research to evaluate EO-1 advanced technologies for their ability to provide reduced cost and enhanced capability Landsat-class observations should offer one or more of the following types of analysis.

1. Evaluation of the ability of the ALI to produce calibrated, multispectral images of the Earth's surface. Such evaluations may include, but are not limited to 1) evaluation of the quality of EO-1 MS/Pan derived spectral reflectance against similarly determined reflectance derived from ETM+, 2) assessment of the capability of the MS/Pan to meet the needs of the Landsat user community through direct comparison with results obtained with past Landsat and concurrent Landsat 7 observations, and 3) assessment of the efficacy of the different calibration modes over the first year on orbit.

2. Evaluate the utility of Hyperion data for synthesizing Landsat multispectral bands. Such evaluations should focus on, but need not be limited to, direct comparison of Landsat bands and bands synthesized by an appropriate aggregation of Hyperion bands. Evaluation of the impacts of using synthesized bands in specific application areas or in algorithms used in traditional Landsat data analysis also would be relevant.

3. Evaluate the improvements to atmospheric correction through use of data from the LAC. Analyses in this area should evaluate the improvements to atmospheric correction of Landsat-class observations (both ALI and Landsat 7) through use of data from the LAC. Also of interest are comparisons of the results derived with the LAC to those derived using Hyperion data.

4. Evaluate the quality and validity of derived data products produced with EO-1 data. It will be important to understand how well EO-1 data can be used to create the same types of derived data products that are currently being created from Landsat data as well as new data products. Representative activities might include: 1) production of spectral vegetation indices, thematic maps (e.g., of urban areas), assessments of snow cover, land cover/land use change, land surface temperature (day and night) data sets, fire assessments, maps of thermal anomalies and burn scars, or maps of soils and geological features, 2) assessment of the capability of EO-1 instruments to meet the needs for seasonal and long term land cover change monitoring -- this could include assessment of vegetation vigor and stress, canopy chemical composition, and canopy biophysical properties (e.g., fraction absorbed photosynthetically-active radiation

(FPAR), leaf area index (LAI), and net primary production (NPP)), and 3) assessment of the capability of EO-1 instruments to meet new user needs for information on coastal processes, environmental change, snow and surface cover, and atmospheric conditions.

5. Evaluation of ALI, Hyperion, and/or LAC sensor performance. Proposals that directly measure and validate sensor performance are relevant to address this topic. Such approaches might include: characterization and analysis of radiometric calibration, quantitative assessment of instrument performance parameters (e.g., 12 bit versus 8 bit quantization), and cross-calibration with other instruments (*e.g.*, ETM+, ASTER, MODIS).

B. Hyperspectral Applications

Research to evaluate space-based imaging spectrometers for potential future scientific and applied uses should offer one or more of they following types of analysis.

1. Evaluation of particular science and applications uses of hyperspectral data. Scientific and applied uses of hyperspectral image data have been demonstrated using field or airborne data sets (e.g., AVIRIS, CASI) in the following areas of study: land cover and land use change, terrestrial ecology, hydrology, oceanography, geology, natural hazards, agriculture and forestry, and atmospheric and radiation dynamics. Investigations, which conduct similar demonstrations from space of the most scientifically important and useful of these applications, are sought. Potential commercial applications are relevant in this area (but see section V.A). Studies to explore new scientific or applied uses of hyperspectral data that would be of high priority to the NASA ESE and USGS are also invited. Focus in this analysis area should be on the use of Hyperion, but studies using the coarse spatial resolution LAC also may be of potential interest.

2. Evaluation of Hyperion, and/or LAC sensor performance. Proposals that directly measure and validate sensor performance are relevant to address this topic. Such approaches might involve characterization and analysis of radiometric calibration or quantitative assessment of instrument performance. Of particular interest, are studies that evaluate the performance characteristics of Hyperion for calibration, repeatability of data, and impacts of atmospheric conditions.

3. Comparison of Hyperion performance with that of other satellite sensors. NASA and USGS are interested in learning about the utility of Hyperion's high spectral and spatial resolution data in enhancing the data products derived from Landsat or other relevant satellite instruments. This could be achieved through participation in cross-instrument validation activities and might involve sub-pixel analysis of coarser resolution imagers. Evaluation of Hyperion performance in comparison with other contemporaneously flying satellite hyperspectral sensors, if data from such could be made available to NASA, would be of interest. NASA and the sponsors and developers of the U.S. Navy's NEMO and U.S. Air Force's Warfighter-1 have been discussing possible future cooperative activities among these missions. Such cooperation has not been fully defined or agreed to yet, but would probably be focused on both scientific and technology performance assessment and sensor calibration/data validation at common test sites. Space agencies in other countries have interests in hyperspectral data and several have been or are involved in spaceborne and/or airborne sensor development; proposals offering collaboration in sensor performance evaluation and hyperspectral data validation with such programs, including

use of airborne sensors for underflight of satellite sensors, would be most welcome under this opportunity.

C. Calibration

Research under the EO-1 Validation Program to evaluate new ways of conducting missions should focus on the EO-1 instrument and spacecraft technologies that impact data quality and the complexity or quality of data correction and/or processing procedures. The greatest emphasis in this area should be on the approaches to atmospheric and other corrections and to calibration of the data. The following types of analyses would be relevant.

1. Evaluation of approaches to calibration. Such approaches might include assessment of the efficacy of different calibration modes during the first year of orbit, including lunar calibration, and evaluation of inter-satellite cross-calibration approaches.

2. Evaluation of approaches to atmospheric correction. NASA and USGS are very interested in determining the potential for improving land surface data by applying LAC-derived atmospheric water vapor corrections to Landsat 7 ETM+ as well as EO-1 ALI observations. Such research may include (1) use of the LAC data (under both cloud-free and cloudy conditions) to correct the ALI data for the effects of atmospheric extinction,
(2) use of the LAC data to retrieve atmospheric parameters such as water vapor, aerosols and clouds, and exploitation of the hyperspectral character of the LAC to infer additional surface properties (plant liquid water content, cloud/snow differentiation and snow-field extent, etc.) at the resolution scale of this instrument, (3) use of the LAC data to correct Landsat 7 ETM+ data for the effects of atmospheric extinction and inter-comparison of these results with those obtained from corrections generated with EOS Terra data (i.e., data from MODIS and MISR), (4) assessment of the impact of using a 250 m pixel size by comparing the resultant corrections with those obtained from the 30 m Hyperion data. This work also is relevant to and, in fact, overlaps with the Landsat continuity activities described in section IV.A.3 above.

3. Evaluation of the impacts of formation flying with other satellites and autonomous navigation/instrument operation on correction and calibration. NASA has been addressing the benefits of supporting ESE mission requirements through multiple sensors distributed among a number of satellites. While this reduces the potential for catastrophic loss of a mission, it raises many issues of near-simultaneous, non-boresighted observations. The formation flight of EO-1 and Landsat 7 (and also EOS Terra) provides an opportunity to address some of these issues through near-simultaneous data acquisitions. Detailed studies which focus on multi-satellite data acquisition that include EO-1 are of interest. Other topics of potential interest include correlation of ephemeral changes in EO-1 data compared to Landsat 7 data with station-keeping data and the ability to detect and measure very short time constant or high rate of change phenomena.

V. GUIDANCE FOR PROPOSERS

A. Available NASA Funding

Approximately $3 M, to be allocated over two years, are available through the EO-1 Project for EO-1 Validation research to address the Landsat Data Continuity and Calibration objectives (IV.A and IV.C above). The NASA ESE Research Division and Applications and Outreach Division will entertain proposals to address primarily the non-commercial Hyperspectral Science and Applications objectives (IV.B above). Program Managers in the following discipline areas have agreed to consider funding one or more proposals each for periods of up to 2 or 3 years: Terrestrial Ecology, Land Cover and Land Use Change, Hydrology, Ocean Biogeochemistry, Geology, and Natural Hazards. This will add roughly an additional $2-4 M over three years. In addition, the NASA Commercial Remote Sensing Program (CRSP) encourages no-cost or low-cost proposals from current NASA Earth Observation Commercial Applications Program (EOCAP) investigators to address commercial applications of hyperspectral data and related Hyperion data validation objectives under this EO-1 opportunity (IV.B above).

B. Available USGS Funding

The USGS National Mapping Division will allocate approximately $400,000 to fund projects during the 1999-2000 portion of the EO-1 Validation Program (pending the availability of appropriated funds), with the prospect of continued support during 2001. The USGS is interested in all three science objectives outlined in this NRA. Among the research issues of particular interest to the USGS are: (1) instrument performance and data validation that documents the extent to which EO-1 technologies might be applied to a Landsat 7 follow-on mission; (2) the role of hyperspectral data in geologic mapping, as well as in DOI land management programs; and (3) environmental monitoring with particular emphasis on vegetation and land cover change, soil and vegetation degradation, and natural hazards.

C. Eligibility

Participation in the EO-1 Validation program is open to all categories of domestic and foreign organizations, including educational institutions, industry, non-profit institutions, NASA research centers, and other government agencies and laboratories (including Federally Funded Research and Development Centers). Civil servants in other U.S. government research laboratories are eligible to apply, but may not request civil service salary reimbursement.

Participation by non-U.S. institutions is strongly encouraged within the specific guidelines described in Appendix C, which include a no-exchange-of-funds provision (USGS will consider support for no-cost, non-U.S. proposals under the same guidelines as NASA). NASA and USGS recognize that the Landsat user community as well as the interest and expertise in hyperspectral remote sensing are international in scope, and is eager to pursue international investigations and collaborations within the EO-1 Validation program. This program offers an opportunity to develop strong partnerships that would build a vigorous, internationally based user community for future science, applications, and/or commercial satellite missions.

D. Limited Resources and Priorities

The funding that NASA and the USGS have identified (in sections V.A and V.B above) for the EO-1 Validation Program is limited and will not stretch to comprehensively address all of the

types of EO-1 validation studies called for in section IV. Thus, proposals that focus on core NMP EO-1 mission priorities and/or address multiple objectives (without becoming diffuse or unfocused) are especially encouraged. Proposals that offer significant cost sharing, as described below, and meet the objectives of this NRA will be given strong consideration.

NASA and USGS specifically encourage researchers already involved in relevant ESE and USGS missions and field campaigns and the NASA EOCAP to submit proposals for no-cost or low-cost EO-1 evaluation and validation research. NASA and USGS also encourage other U.S. government agencies with remote sensing missions and/or applications responsibilities to submit proposals for no-cost or low-cost EO-1 evaluation and validation research.

E. Technical Information and Instructions for Proposers

Appendix A provides technical background on the EO-1 instruments and a list of acronyms used in this announcement. Appendix B provides amendatory guidance to the general guidelines for responding to NASA Research Announcements contained in Appendix C for the EO-1 Validation Program and guidance for proposers. Appendix C contains general instructions for responding to NASA Research Announcements. Appendix D contains instructions for foreign participation in this opportunity. Appendix E contains examples of the proposal cover page and required institutional declarations (now made a part of the cover page) and a budget summary form. Appendix F provides the URL addresses for accessing World Wide Web home pages with information relevant to this NRA. If electronic access is not available to the prospective proposers, a hard copy of relevant reference(s) can be requested by calling (202) 358-3552 and leaving a voice mail message. Please leave your full name and address, including zip code, and your telephone number, including area code. Appendix G provides instructions for submitting letters of intent electronically. *Prospective investigators are urged to read the information in all of the Appendices carefully and to follow the specific guidelines therein carefully.*

F. Proposal Submission and Review

All prospective proposers are requested to submit a letter of intent to propose to NASA in response to this announcement by no later than May 17, 1999. This letter will be used to expedite joint NASA and USGS planning for the peer review. Proposers are strongly encouraged to submit their letter of intent electronically by completing the forms at: http://www.earth.nasa.gov/loi (see also Appendix G). If this is not possible, NASA will accept a FAX copy containing the information described in Appendix G sent to (202) 554-3024.

Proposals may be submitted at any time during the period ending at 4:30 pm, EDT, on June 17, 1999. Detailed information on proposal format and content and the peer review process is provided in Appendix B.

A complete schedule for the EO-1 Validation program is given below:

Letter of Intent Due:	4:30 pm, EDT, May 17, 1999
Proposals Due:	4:30 pm, EDT, June 17, 1999

Peer Review:	July-August, 1999
Announcement of Final Selections:	October, 1999
Anticipated Award Start Date(s):	November 15, 1999 - January 1, 2000
EO-1 Launch	December, 1999

The following items apply only to this announcement.

Identifier:	NRA-99-OES-01
Submit Proposals to:	EO-1 Code Y 400 Virginia Avenue, SW, Suite 700 Washington, DC 20024 USA

For overnight mail delivery purposes only the recipient telephone number is (202) 554-2775.

Number of Copies Required:	15
Submit One Additional Copy of Proposals with **Non-U.S. Participants** to:	NASA Headquarters Office of External Relations Earth Science Division Mail Code IY 300 E Street, SW Washington, DC 20546

NASA Selecting Officials for EO-1 Validation Program: Director, Science Division and Director, Applications and Outreach Division Office of Earth Science

Obtain Additional Information from:

Dr. Diane E. Wickland
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Diane.Wickland@hq.nasa.gov

Your interest and cooperation in participating in this opportunity are appreciated.

Dr. Ghassem R. Asrar
Associate Administrator for
Office of Earth Science

Enclosures:

Appendix A - Technical Information on EO-1 Instruments and List of Acronyms Used in this Announcement
Appendix B - Amendatory Guidance to the General Guidelines Contained in Appendix C and Applicable Only to this NRA and Instructions for Proposers
Appendix C - Instructions for Responding to NASA Research Announcements
Appendix D - Guidelines for Foreign Participation
Appendix E - Proposal Cover Page, Required Declarations, and Budget Summary Form
Appendix F - Electronic Addresses
Appendix G - Instructions for Submitting Letters of Intent Electronically

APPENDIX A

TECHNICAL INFORMATION ON NMP, EO-1 INSTRUMENTS AND OPERATIONS, AND LIST OF ACRONYMS

1. NEW MILLENNIUM PROGRAM (NMP) AND EARTH OBSERVER –1 (EO-1)

NMP missions are intended primarily to validate technologies in flight by providing useful science data to the user community. The goal is to make future operational spacecraft "faster, cheaper and better" through incorporation of the technologies validated in the NMP. The Earth Observer missions will flight-validate advanced technologies for the next generation Earth Science Enterprise science needs. In the first Earth Observer mission, the EO-1 satellite, will be in an orbit that covers the same ground track as Landsat 7, approximately one minute later. The objective is to obtain images of the same ground areas at nearly the same time, so that direct comparison of results can be obtained for Landsat-ETM+ and the three primary E0-1 instruments. The three primary instruments are the Advanced Land Imager (ALI), the Hyperion and the Linear Etalon Imaging Spectrometer Array (LEISA) Atmospheric Corrector (LAC).

The EO-1 ALI consists of a 15° Wide Field Telescope (WFT) and partially populated focal plane occupying 1/5th of the field-of-view, giving a ground swath width of 37 km. Hyperion is a grating imaging spectrometer having a 30 meter ground sample distance over a 7.5 kilometer swath and providing 10nm (sampling interval) contiguous bands of the solar reflected spectrum from 400-2500nm. LAC is an imaging spectrometer covering the spectral range from 900 to 1600 nm which is well suited to monitor the atmospheric water absorption lines for correction of atmospheric effects in multispectral imagers such as ETM+ on Landsat. A summary of instrument characteristics is given in Figure 1. Details of the three instrument characteristics are provided in the following sections. A comparison with Landsat 7 is included.

	MULTISPECTRAL		HYPERSPECTRAL	
	Landsat 7	EO-1	EO-1	
Parameters	ETM+	ALI	HYPERION	LAC
Spectral Range	0.4 - 2.4* µm	0.4 - 2.4 µm	0.4 - 2.5 µm	0.9 - 1.6 µm
Spatial Resolution	30 m	30 m	30 m	250 m
Swath Width	185 Km	37 Km	7.5 Km	185 Km
Spectral Resolution	Variable	Variable	10 nm	2-6 nm
Spectral Coverage	Discrete	Discrete	Continuous	Continuous
Pan Band Resolution	15 m	10 m	N/A	N/A
Number of Bands	7	10	220	256

*excluding thermal band

Figure 1. Summary of Primary EO-1 Instrument Characteristics

2. Advanced Land Imager (ALI)

ALI is designed to produce images directly comparable to those of the Enhanced Thematic Mapper Plus (ETM+) of Landsat 7. Ultimately, it is anticipated that ALI support can establish data continuity with previous Landsats and demonstrate advanced capability and innovative approaches to future land imaging

The essential features of the ALI instrument are schematically depicted in Figures 2. This diagram shows the main thermal, mechanical, and electronic components.

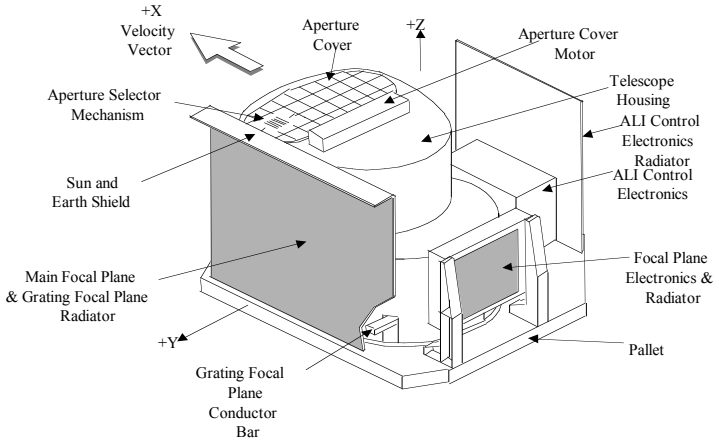

Figure 2. ALI Instrument Configuration

The telescope is a reflective triplet design with a 12.5 cm unobscured aperture diameter and a field of view (FOV) of 15° by 1.256°, as illustrated in Figure 3. It employs reflecting optics throughout, to cover the fullest possible spectral range. The design uses four mirrors: the primary is an off-axis asphere, the secondary is an ellipsoid, and the tertiary is a concave sphere; the fourth mirror is a flat folding mirror. This technology will enable the use of large detector arrays in the focal plane to cover the entire 185 km swath equivalent to Landsat in a "push broom" mode. The optical design features a flat focal plane and telecentric performance, which greatly simplifies the placement of the filter and detector array assemblies.

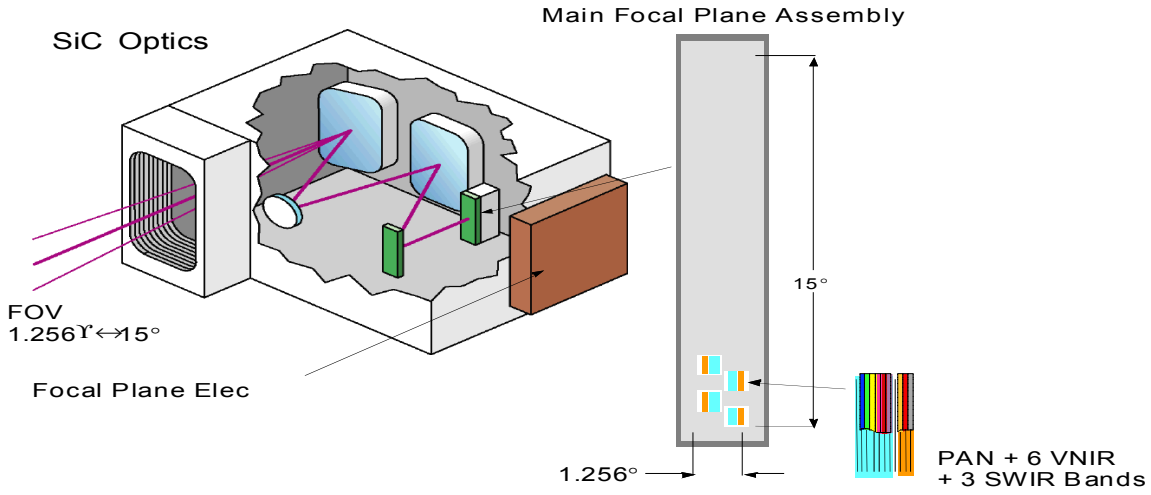

Figure 3. Conceptual Layout of the ALI Optical System and Focal Plane Detector Arrays

The design features silicon carbide mirrors and an Invar structure with appropriate mounting and attachment fittings. Silicon carbide has many favorable properties for space optical systems. It possesses high stiffness, high thermal conductivity, and low thermal expansion. Although it has been used for space optical elements previously, it has not been used for such large mirrors of this design.

For the EO-1 technology demonstration, a 3-degree FOV segment within the focal plane is populated with detectors, giving a crosstrack coverage of 37 Km. The intent is to provide adequate flight validation of the imaging technologies within the EO-1 program cost and schedule constraints. The multispectral/panchromatic (MS/Pan) array has 10 spectral bands in the visible/near infrared (VNIR) and short wave infrared (SWIR). The pan covers the visible portion of the VNIR spectrum and has a 10m spatial resolution. The MS detectors have a 30 m resolution. Four sensor chip assembles (SCA's) make up the focal plane. For every MS band, each SCA contains 320 detectors in the cross-track direction, while the pan band contains 960 detectors. The pan enhances spatial resolution, and the multispectral enhances both the number of channels and signal-to-noise with respect to Landsat ETM+.

The MS/Pan arrays use VNIR detectors integrated with the Readout Integrated Circuit (ROIC). The SWIR detectors made of mercury-cadmium-telluride (HgCdTe) promise high performance over the 900 to 2500nm spectral region at temperatures which can be reached by passive or thermoelectric cooling. The nominal focal plane temperature is 220°K and is maintained by the use of a radiator. The spectral coverage is summarized in Figure 4.

Band	**Wavelength (nm)**	**Band**	**Wavelength (nm)**
Pan	480-690	MS-4	775-805
MS-1'	433-453	MS-4'	845-890
MS-1	450-515	MS-5'	1200-1300
MS-2	525-605	MS-5	1550-1750
MS-3	630-690	MS-7	2080-2350

Figure 4. Summary of the ALI Spectral Coverage

The Advanced Land Imager will demonstrate an innovative approach toward accurate radiometric calibration on orbit using precisely controlled amounts of the incident solar irradiance. The calibration will be performed using a controlled variable aperture and a Spectralon diffuser deployed in front of the secondary mirror. In addition, the inflight calibration plan includes a three level internal source, lunar calibration and vicarious ground calibration. The goals are to achieve 5% absolute and 2% relative radiometric calibration accuracy.

Both the operability and signal-to-noise are excellent Based on measurements, the average pixel operability of the four SCA's is 99.97% in Pan, 99.99% in MS-VNIR and 99.77% in MS-SWIR. The signal-to-noise ratio (SNR) of each SCA has been calculated in each of the bands from the measured performance, for 5% Earth surface SNR reflectance. The resulting of one of the SCA's is shown in Figure 5, where it is compared to the SNR measured for the ETM+ instrument of Landsat 7. The measured telescope wavefront error at 0.6328 μm is 0.083λ on axis, with an average value of 0.111 λ over the field of view (twelve points).

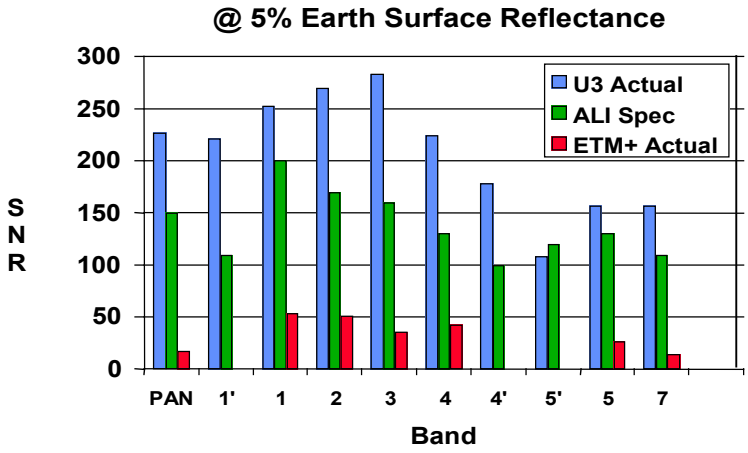

Figure 5. MS/Pan Signal to Noise Ratio at 5% Earth Reflectance Compared with the ETM+

3. Hyperion

The focus of the Hyperion instrument is to provide high quality calibrated data that can support evaluation of hyperspectral technology for Earth observing missions. The Hyperion is a pushbroom instrument. Each image frame taken in this "push broom" configuration captures the spectrum of a line 30m long by 7.5Km wide (perpendicular to the satellite motion). Frames are then combined to form a two dimensional spatial image with a complete spectral signature for each pixel. Hyperion has a single telescope and two spectrometers, one visible/near infrared (VNIR) spectrometer and one short-wave infrared (SWIR)) spectrometer. The Hyperion instrument consists of 3 physical units (Figure 6): (1) the Hyperion Sensor Assembly (HSA); (2) the Hyperion Electronics Assembly (HEA); and (3) the Cryocooler Electronics Assembly (CEA).

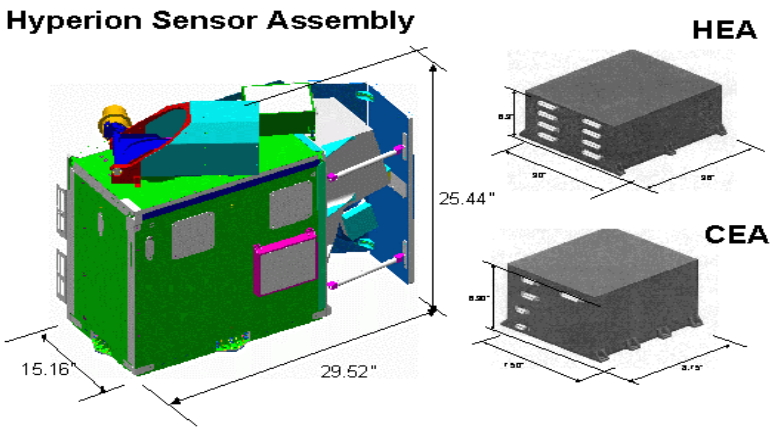

Figure 6. Hyperion Instrument Subsystems

The Hyperion Sensor Assembly (HSA) includes the telescope, the two grating spectrometers and the supporting focal plane electronics and cooling system. The Hyperion telescope (fore-optics) is a three-mirror astigmate design. The telescope images the Earth onto a slit that defines the instantaneous field-of-view which is 0.624^0 wide (i.e., 7.5 Km swath width from a 705 Km altitude) by 42.55 μ radians (30 meters) in the satellite velocity direction. This slit image of the Earth is relayed at a magnification of 1.38:1 to two focal planes in the two grating imaging spectrometers. A dichroic filter in the system reflects the band from 400 to 1,000 nm to one spectrometer and transmits the band from 900 to 2,500 nm to the other spectrometer. The SWIR overlap with the VNIR from 900 to 1000 nm will allow cross calibration between the two spectrometers. Both spectrometers use a JPL convex grating design in a 3 reflector Offner configuration.

The visible/near-infrared (VNIR) spectrometer has an array of 60 μm pixels created by aggregating 3x3 subarrays of 20 μm CCD detectors. The VNIR spectrometer uses a 60 (spectral) by 250 (spatial) pixel array, which provides a 10 nm spectral bandwidth over a range of 400-1000 nm. The shortwave infrared (SWIR) spectrometer has 60 μm cooled HgCdTe detectors (120 K) in an array of 160 (spectral) x 250 (spatial) channels. Similar to the VNIR, the SWIR spectral bandwidth is 10 nm. Thus, the spectral range of the instrument extends from 400 to 2,500nm with a spectral resolution of 10nm.

The telescope and imaging spectrometer are pinned and bolted together, permitting alignment of the two sections to take place independently. All of the mirrors in the system are constructed from coated aluminum; the structure holding the optical elements is also constructed from aluminum so that the mirrors and housing all expand and contract at the same rates. This results in an athermal design over a limited temperature range. In operation, the housing will be maintained at $20^0 \pm 2^0$C for precision imaging and alignment.

A common calibration system is provided for both the VNIR and SWIR spectrometers. Dual calibration lamps produce reference signals to monitor detector performance following image acquisition. Solar calibration, vicarious ground calibration, and lunar calibration are also planned. The long term absolute radiometric calibration goal is 6%. A calibration baseline will be established in the laboratory during instrument checkout. After integration of the instrument onto the spacecraft, the performance will be verified. During the initial on-orbit checkout, the internal calibration will be cross-referenced against both solar and lunar calibrations. The solar calibration will utilize a diffuse reflector on the backside of the optical cover to provide uniform illumination across the focal plane arrays. Direct viewing lunar calibration will be accomplished by scanning the instrument across the lunar surface. Solar and in-flight calibration data will be used as the primary source for monitoring radiometric stability, with ground site (vicarious) and lunar calibration secondary.

Vicarious ground calibration (viewing target calibration sites on the Earth) is part of both the instrument checkout and continued monitoring of instrument performance during the life of the mission. Terrestrial sites are chosen to provide high SNR, geographic and spectral flatness, and minimal atmospheric disturbance. Selected ground calibration activities include geolocation (measured using the Iowa road system) and contrast (by imaging the San Francisco Bay with its long bright bridges over dark water).

The calculated Hyperion instrument performance shown in Figure 7 is based on the measured performance of the focal planes and a model of the optical design. The baseline conditions assumed for the performance model are a 60^{o} Solar Zenith Angle and a 30% uniform Albedo; the instrument design assumes F/11 optics, a 10nm bandwidth and a 224 Hz frame rate.

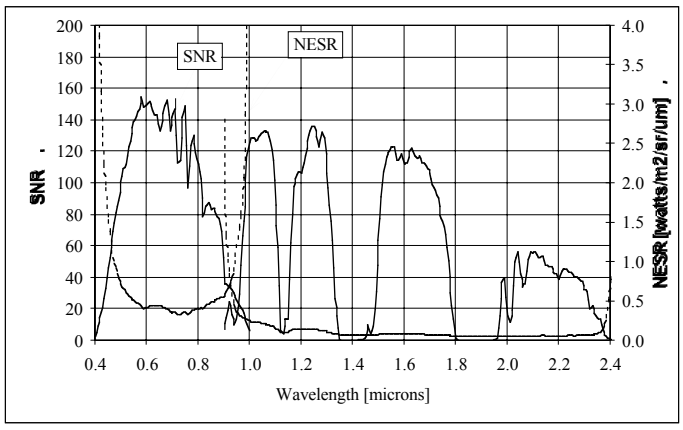

Figure 7. Signal-to-Noise and Noise Equivalent Spectral Radiance (NESR) Characteristics of the Hyperion Instrument

The footprint of Hyperion will be boresighted with the ALI pan band (at ~5^{o} from nadir) and LAC to allow direct cross comparisons. The data will typically be processed into cubes (19.8 km long by 7.5km wide) to facilitate data handling in current desktop computers. Each cube will consist of 75 M Bytes of data. A typical acquisition will consist of multiple cubes.

4. LEISA Atmospheric Corrector (LAC)

The third EO-1 instrument is the LEISA Atmospheric Corrector (LAC). The LAC will use three 256 x 256 pixel InGaAs IR detector focal plane assemblies in a single module (see Figure 8.). Each array will be placed behind a lens covering a five degree field of view to obtain a swath width of 185 km (15 degrees). A state-of-the-art wedged dielectric film etalon filter (a linear variable etalon) is placed in very close proximity to a two-dimensional IR detector array. This produces a 2-D spatial image that varies in wavelength along one dimension. The filter is 1.024 cm x 1.024 cm and covers the 890 to 1600nm spectral region at a resolution of 30 – 40 cm^{-1}, with a linear dependence of wavenumber on position. Reflective _-wave stacked layers placed on both sides of one, or more, _-wave etalon cavity(s) provide the spectral resolution. Order-sorting of the etalon is accomplished with lower resolution filter layers. In operation, the two-dimensional spatial image is formed by a small, wide field of view lens. Unlike the grating spectrometer that captures the spectra at a point "instantaneously", the spectrum for the LAC is obtained as the orbital motion of the spacecraft scans the image across the focal plane in wavelength, thereby creating a three-dimensional spectral map. The spatial resolution is determined by the spatial resolution of the imaging optic, the image scan speed, and the readout rate of the array. For the EO-1 application, the single pixel spatial resolution is 360 x 360 $\mu radian^2$, corresponding to a single pixel field of view of 250 m x 250 m (at nadir) from a 700 Km orbit and a readout rate of approximately 30 Hz. Because the spatial resolution is relatively coarse (250 meters) and the wedge uses light efficiently, the optical system is compact. This design simplicity is offset by the need to build up the spectral image over a series of frames, increasing the satellite attitude control system requirements. For LAC, the large pixel size minimizes this impact.

The LAC is intended to correct for water vapor variations using the information in the 890 to 1600nm region and to detect cirrus clouds (through the 1380nm channel). In addition to atmospheric monitoring, LAC will also image the Earth and provide an opportunity to test the wedge imaging spectrometer concept. The imaging data will be cross-referenced to the Hyperion data where the footprints overlap.

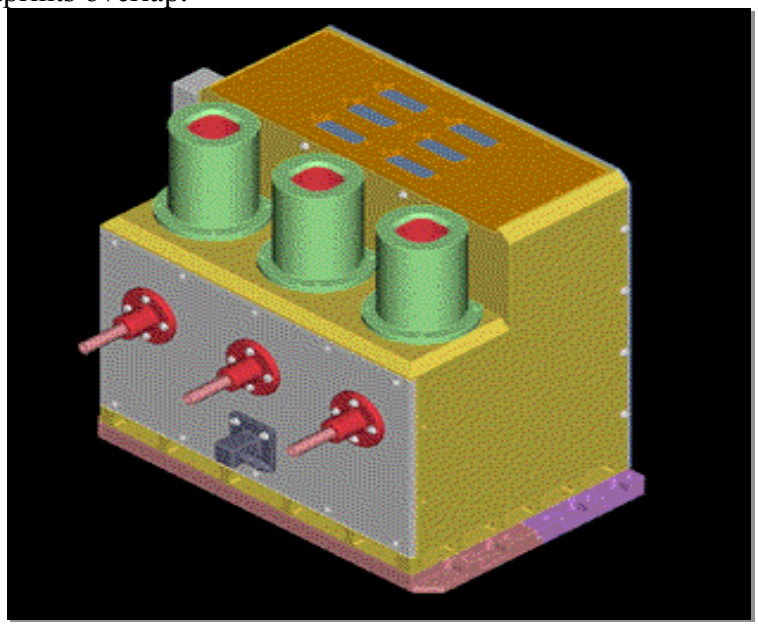

Figure 8. The LAC Provides Atmospheric Correction Data for Landsat and ALI

5. Operations

The EO-1 Mission will be launched on a Delta 7320 from Vandenberg Air Force Base in December 1999. EO-1 will fly in a 705km circular, sun-synchronous orbit at a 98.7 degree inclination. This orbit allows EO-1 to match the Landsat-7 orbit within one minute, and collect nearly identical images for later comparison on the ground.

EO-1 data collections will be taken on approximately three orbits per day. A data collection event (DCE) includes all internal calibrations needed to support the data collection, which may be imaging, ground calibration, lunar calibration, or solar calibration. For each DCE, approximately 10 Gbits of scene data from the Advanced Land Imager, Hyperion and Atmospheric Corrector will be collected and stored in the on-board solid state data recorder. When the EO-1 spacecraft is in range of a ground station, the spacecraft will transmit its recorded image data to the ground station for temporary storage. The ground station will store the raw data on digital tapes which will be periodically sent via overnight mail delivery to the Goddard Space Flight Center for processing and then forwarded to the EO-1 science and technology teams for validation and research purposes.

Standard image sizes have been developed to facilitate data processing. For ALI and LAC, the standard image mirrors the Landsat image length of 180Km. For the Hyperion, an image, or cube, consists of 660 frames of data (19.8 Km long by 7.5 Km wide) and takes about 3 seconds to collect; an image equivalent to a Landsat scene is nine cubes, and takes 27 seconds. Data collection of longer images is possible for special requirements. In addition to user requested DCEs, lunar calibration is performed once per month; solar calibration is performed about once per week. A typical imaging collection will include a dark calibration before and after the imaging data collection, and a white calibration following the second dark calibration. Current planning has all three instruments operating simultaneously.

II. ACRONYMS

ALI: Advanced Land Imager
AM-1: first EOS platform with a morning crossing time
AVIRIS: Airborne Visible/Infrared Imaging Spectrometer
CASI: Compact Airborne Spectrographic Imager
CCD: Charge Coupled Device
CEA: Cryocooler Electronics Assembly
CRSP: Commercial Remote Sensing Program
DAAC: Distributed Active Archive Center
DCE: Data Collection Event
DOI: Department of Interior
EDC: EROS Data Center
EO-1: Earth Observing-1
EOCAP: Earth Observation Commercial Applications Program
EOS: Earth Observing System

EOSDIS: EOS Data and Information System
EROS: Earth Resources Observation Systems
ESE: Earth Science Enterprise
ETM+: Enhanced Thematic Mapper Plus
FOV: Field of View
GSD: Ground Sample Distance
GSFC: Goddard Space Flight Center
HEA: Hyperion Electronics Assembly
HSA: Hyperion Sensor Assembly
JPL: Jet Propulsion Laboratory
LAC: Linear Etalon Imaging Spectral Array (LEISA) Atmospheric Corrector
LEISA: Linear Etalon Imaging Spectral Array
MISR: Multi-angle Imaging SpectroRadiometer
MOC: Mission Operations Center
MODIS: Moderate Resolution Imaging Spectrometer
MOPSS: Mission Operations Planning and Scheduling System
MSO: Mission Science Office
MSS: Multispectral Scanner System
NASA: National Aeronautics and Space Administration
NEMO: Naval EarthMap Observer
NESR: Noise Equivalent Spectral Radiance
NMP: New Millennium Program
NPP: Net Primary Productivity
ROIC: Readout Integrated Circuit
SCA: Sensor Chip Assemblies
SNR: Signal-to-Noise Ratio
SSC: Stennis Space Center
SWG: Science Working Group
SWIR: Short-Wave Infrared
TM: Thematic Mapper
USGS: United States Geological Survey
VNIR: Visible/Near Infrared
WARP: Wide-band Advanced Recorder Processer
WFT: Wide Field Telescope

APPENDIX B

AMENDATORY GUIDANCE TO THE GENERAL GUIDELINES CONTAINED IN APPENDIX C AND APPLICABLE ONLY TO THIS NRA AND INSTRUCTIONS FOR PROPOSERS

I. PURPOSE

These guidelines contain general and specific information regarding the submission of proposals in response to this NRA. Formats for submission of proposals for research related to this program are provided. The evaluation criteria are specified. Appendix C contains general instructions for responding to NASA Research Announcements. Where conflicts exist between this Appendix and Appendix C, this appendix shall be the controlling document.

II PROPOSAL CONTENT AND FORMAT

The proposal should provide sufficient detail to enable a reviewer to assess the value of the proposed research, its relation to EO-1 Validation objectives, and the probability that the investigators will be able to accomplish the stated objectives within the requested resources and schedule. Capabilities of the proposing organizations should be described including the experience of the Principal Investigator and any co-investigators. The technical part of the proposal should be limited to the equivalent of 14 pages of text, single-spaced, with type no smaller than 12 pt., including references. A reasonable number of figures and tables (not to exceed 5 pages) may be appended. The cover page, table of contents, abstract, management plan, data plan, description of facilities and equipment, cost plan, and short resumes need not count in the 14-page limit. Additional pertinent information (e.g., reprints, letters indicating the commitment of co-investigators and collaborators or international partners) may be added as appendices.

A. Page Limits

Offerors should adhere to the following page limits:

Cover Letter	1	
Cover Page	1-2	
Table of Contents	1	
Abstract	1	
Technical Plan	14	
Introduction/Background		(≤4)
Description of Research Approach		(~10)
Data Plan	1/2 - 1	
Management Plan	1/2 - 2	
Cost Plan	3 - 8	
Resumes	1 - 2 per investigator	

Declarations and Certifications	3 (if not made part of cover page)
Other	As few as possible

B. Content

Each proposal should contain the following materials assembled in the order given.

1. Cover Letter. Each proposal should be prefaced by a cover letter signed by an official of the investigator's institution who is authorized to legally bind the organization to the proposal and its content (unless the signature appears on the proposal itself). The cover letter should refer to the EO-1 Validation Program.

2. Proposal Cover Page. The proposal cover page should contain the following: a short, descriptive title for the proposed effort; the name of the proposing organization(s); names, addresses, telephone numbers, FAX numbers, electronic mail addresses, and affiliations of the Principal Investigator and all Co-Investigators; and a year by year budget summary, including a total for all years. An example cover page is provided in Appendix D. **The required institutional declarations and certifications have been incorporated in this new cover page form. Separate forms will not be required if this cover page is used; if it is not, the separate forms must be submitted** (see Appendix D).

3. Table of Contents (recommended length: 1 page). A table of contents listing the page numbers for key sections of the proposal, including the data, management, and cost plans, should be provided.

4. Abstract (length must not exceed 1 page). The abstract should summarize the research proposed in one page or less. It should contain a simple, concise overview of the investigation, its objectives, its scientific approach, expected results, and the value of its results to the EO-1 Validation Program. It is very important that this abstract be specific and accurately represent the research to be conducted.

5. Technical Plan (length must not exceed 14 pages). The main body of the proposal should contain a full statement of the research to be undertaken and should describe key background, objectives, scientific relevance, technical approach, and expected significance of the work. The key elements of the project should be clearly identified and related to each other. The methods or approaches to be used should be described, and, as appropriate, the advantages of the selected methods or approaches over alternatives should be discussed. The anticipated results should be identified and their relation to the proposal's stated objectives and the objectives of EO-1 Validation should be discussed. The research should be described in sufficient detail that peer reviewers can adequately assess the scientific methods and quality of the work proposed. The introduction and background section of the technical plan should not exceed four pages.

A list of references used in the Technical Plan should be provided.

6. Data Plan (recommended length: 1/2 - 1 page). All proposals should provide a brief Data Plan describing the investigator's commitment to and plans for sharing data and for interacting

with the EO-1 science validation facility. This plan should describe the type and amount of data to be requested from EO-1, the desired dates for acquisition and delivery, and the geographic location(s) to be imaged. Where resources from satellites other than EO-1 or other data sources (e.g., aircraft sensors) are required, proposals should indicate whether a commitment has been made for access to the other systems or whether the required/desired data are available. The plan should also describe how any data products to be created or additional, ancillary data sets to be obtained will be shared with NASA, USGS, other investigators, and the broader science and user community. *Resources (i.e., personnel equipment, funds) for supporting the Data Plan should be identified in the Cost Plan.*

7. Management Plan (recommended length: 1/2 - 2 pages, depending on complexity). The Management Plan should outline the roles and responsibilities of all investigators and collaborators and indicate the relationships among these roles and responsibilities within the group. The management plan should also identify what contractor and/or non-institutional support is anticipated and who will be providing it. A schedule for reporting results and publishing papers should be described.

8. Cost Plan for U.S. Proposals Only (recommended length: 1 page per budget year, 1 budget summary page, 1/2 - 2 pages of explanation/justification, 1/2 - 2 pages detailing other funded projects). A detailed cost plan must be provided for each year of the proposed effort. Costs should be broken down into all of the following categories that apply: salaries and wages, including staff-months and rates for all personnel; benefits; supplies; services; equipment purchases; data purchases; computer services; publication costs; communications; travel; other; and overhead. Any unusual requests for funds (e.g., computer equipment, expensive equipment purchases) must be specially justified.

Special attention must be given to providing appropriate justification for the proposed purchase of any personal computers and/or commercially available software, both of which are considered to be "general purpose equipment." In the event that a proposal is selected for award, failure to justify such purchases will require that the NASA awards office contact the proposing institution for the required information, which may delay the award until the purchase is either justified as a direct charge or is re-budgeted under indirect costs.

Participation in EO-1 Validation Team activities must be accounted for in each investigator's Cost Plan. Investigators should budget for at least two meetings per year. For planning purposes, investigators should plan for one 3-day meeting each for the eastern and central/western United States annually.

Contributions from any cost-sharing plan or other support for the proposed research should be detailed. If access to complementary airborne or satellite data sets is being offered by the proposer, such contributions should be noted here, and the conditions of data sharing specified in the data plan.

Current and pending funding from other sources, including the level of funding and the title or brief description of the supported research, must be listed.

9. Resumes. Brief resumes (1-2 pages) for all named investigators should be appended to the proposal.

10. Other Enclosures. Any other material pertinent to the consideration of the proposal may be attached as an Appendix. This might include preprints or reprints of relevant publications, background on new measurement or analysis approaches, or letters of support and/or participation by scientists and/or institutions. Inclusion of general materials that will not aid in the evaluation of the proposal is specifically discouraged.

III. SELECTION PROCESS AND EVALUATION CRITERIA

The review for proposals submitted to the EO-1 Validation program will consist of individual mail reviews by peers with specialized scientific and technical expertise in the research topic(s) being proposed, followed by a panel peer review. Proposals also will be reviewed by NASA and USGS managers to identify any logistical, implementation, cost, and/or management concerns.

A. Evaluation Criteria.

The criteria listed below will be used in evaluating individual proposals. These criteria supersede those listed in section (i) of Appendix C, and are of approximately equal importance.

1. The intrinsic merits of the investigation, including:

   (a) the overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

   (b) the qualifications, capabilities, and relevant experience of the Principal Investigator and any co-Investigators or collaborators as an indication of their ability to carry the investigation to a successful conclusion within the requested resources, including timely publication of peer-reviewed journal articles.

   (c) the adequacy of facilities and ability and commitment of the investigator's institution to provide the necessary support to ensure that the investigation can be completed satisfactorily.

2. The relevance and responsiveness of the proposed research to the goals and objectives of NASA's Earth Science Enterprise or the USGS land remote sensing programs, and to the goals and objectives of the EO-1 Validation program, as described in the announcement, including:

   (a) the probability of achieving one or more significant EO-1 Validation objectives.

(b) the soundness, logic, and practicality of the proposed technical methods and concepts for achieving successful validation.

(c) the potential benefits to future U.S. Earth Science missions or data purchases.

(d) the quality, effectiveness, and appropriateness of the data and management plans; the timeliness of the reporting schedule; and the adequacy of metrics and other statistics to be collected that will measure the success of the activity.

3. The cost of the investigation, including consideration of the realism and reasonableness of the proposed cost, the relationship of the proposed cost to available funds, and the potential value of the validation approach(es) (i.e., cost/benefit) to the user community.

B. Other Considerations

NASA and USGS may desire to accept only a portion of a proposer's investigation, in which case the investigator will be given the opportunity to accept or decline such partial acceptance. In cases in which two or more proposals address similar problems and/or adopt similar approaches to data analysis, NASA and USGS may desire joint participation on the part of two or more proposers in a single project. If such overlap involves more than one funding organization, NASA and those organizations will confer and mutually agree to the disposition of those proposals.

Any negotiations prior to final decisions will occur only after the peer review of proposals has been completed. Final decisions will be made promptly and investigators will be notified through either electronic mail or surface mail. Proposers will receive anonymous copies of the reviews for their proposal(s).

APPENDIX C

INSTRUCTIONS FOR RESPONDING TO NASA RESEARCH ANNOUNCEMENTS

Part 1852.235-72
NASA Federal Acquisition Regulations (FAR) Supplement (NFS)
Version 89.90, Effective March 11, 1997.

Accessible at URL
http://www.hq.nasa.gov/office/procurement/regs/nfstoc.htm, open
Part 1852.228 to 1852.241 from menu.

(JANUARY 1997)

(a) General.

(1) Proposals received in response to a NASA Research Announcement (NRA) will be used only for evaluation purposes. NASA does not allow a proposal, the contents of which are not available without restriction from another source, or any unique ideas submitted in response to an NRA to be used as the basis of a solicitation or in negotiation with other organizations, nor is a pre-award synopsis published for individual proposals.

(2) A solicited proposal that results in a NASA award becomes part of the record of that transaction and may be available to the public on specific request; however, information or material that NASA and the awardee mutually agree to be of a privileged nature will be held in confidence to the extent permitted by law, including the Freedom of Information Act.

(3) NRAs contain programmatic information and certain requirements which apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information which applies to responses to all NRAs.

(4) A contract, grant, cooperative agreement, or other agreement may be used to accomplish an effort funded in response to an NRA. NASA will determine the appropriate instrument. Contracts resulting from NRAs are subject to the Federal Acquisition Regulation and the NASA FAR. Supplement. Any resultant grants or cooperative agreements will be awarded and administered in accordance with the NASA Grant and Cooperative Agreement Handbook (NPG 5800.1).

(5) NASA does not have mandatory forms or formats for responses to NRAs; however, it is requested that proposals conform to the guidelines in these instructions. NASA may accept proposals without discussion; hence, proposals should initially be as complete as possible and be submitted on the proposers' most favorable terms.

(6) To be considered for award, a submission must, at a minimum, present a specific project within the areas delineated by the NRA; contain sufficient technical and cost information to

permit a meaningful evaluation; be signed by an official authorized to legally bind the submitting organization; not merely offer to perform standard services or to just provide computer facilities or services; and not significantly duplicate a more specific current or pending NASA solicitation.

(b) NRA-Specific Items. Several proposal submission items appear in the NRA itself: the unique NRA identifier; when to submit proposals; where to send proposals; number of copies required; and sources for more information. Items included in these instructions may be supplemented by the NRA.

(c) The following information is needed to permit consideration in an objective manner. NRAs will generally specify topics for which additional information or greater detail is desirable. Each proposal copy shall contain all submitted material, including a copy of the transmittal letter if it contains substantive information.

(1) Transmittal Letter or Prefatory Material.

(i) The legal name and address of the organization and specific division or campus identification if part of a larger organization;

(ii) A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;

(iii) Type of organization: e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;

(iv) Name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation;

(v) Identification of other organizations that are currently evaluating a proposal for the same efforts;

(vi) Identification of the NRA, by number and title, to which the proposal is responding;

(vii) Dollar amount requested, desired starting date, and duration of project;

(viii) Date of submission; and

(ix) Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization (unless the signature appears on the proposal itself).

(2) **Restriction on Use and Disclosure of Proposal Information**. Information contained in proposals is used for evaluation purposes only. Offerors or quoters should, in order to maximize protection of trade secrets or other information that is confidential or privileged, place the following notice on the title page of the proposal and specify the information subject

to the notice by inserting an appropriate identification in the notice. In any event, information contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

Notice

Restriction on Use and Disclosure of Proposal Information

The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(3) **Abstract.** Include a concise (200-300 word if not otherwise specified in the NRA) abstract describing the objective and the method of approach.

(4) **Project Description**.

(i) The main body of the proposal shall be a detailed statement of the work to be undertaken and should include objectives and expected significance; relation to the present state of knowledge; and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experimental methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the NRA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.

(ii) When it is expected that the effort will require more than one year, the proposal should cover the complete project to the extent that it can be reasonably anticipated. Principal emphasis should be on the first year of work, and the description should distinguish clearly between the first year's work and work planned for subsequent years.

(5) **Management Approach**. For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and arrangements for ensuring a coordinated effort should be described.

(6) **Personnel**. The principal investigator is responsible for supervision of the work and participates in the conduct of the research regardless of whether or not compensated under the award. A short biographical sketch of the principal investigator, a list of principal publications and any exceptional qualifications should be included. Omit social security number and other

personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(7) **Facilities and Equipment.**

(i) Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling that are proposed for use. Include evidence of its availability and the cognizant Government points of contact.

(ii) Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for research and non-research purposes should be explained.

(8) **Proposed Costs.**

(i) Proposals should contain cost and technical parts in one volume: do not use separate "confidential" salary pages. As applicable, include separate cost estimates for salaries and wages; fringe benefits; equipment; expendable materials and supplies; services; domestic and foreign travel; ADP expenses; publication or page charges; consultants; subcontracts; other miscellaneous identifiable direct costs; and indirect costs. List salaries and wages in appropriate organizational categories (e.g., principal investigator, other scientific and engineering professionals, graduate students, research assistants, and technicians and other non-professional personnel). Estimate all staffing data in terms of staff-months or fractions of full-time.

(ii) Explanatory notes should accompany the cost proposal to provide identification and estimated cost of major capital equipment items to be acquired; purpose and estimated number and lengths of trips planned; basis for indirect cost computation (including date of most recent negotiation and cognizant agency); and clarification of other items in the cost proposal that are not self-evident. List estimated expenses as yearly requirements by major work phases.

(iii) Allowable costs are governed by FAR Part 31 and the NASA FAR Supplement Part 1831 (and OMB Circulars A-21 for educational institutions and A-122 for nonprofit organizations).

(9) **Security**. Proposals should not contain security-classified material. If the research requires access to or may generate security-classified information, the submitter will be required to comply with Government security regulations.

(10) **Current Support**. For other current projects being conducted by the principal investigator, provide title of project, sponsoring agency, and ending date.

(11) **Special Matters.**

(i) Include any required statements of environmental impact of the research, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

(ii) Proposers should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

(d) **Renewal Proposals**

(1) Renewal proposals for existing awards will be considered in the same manner as proposals for new endeavors. A renewal proposal should not repeat all of the information that was in the original proposal. The renewal proposal should refer to its predecessor, update the parts that are no longer current, and indicate what elements of the research are expected to be covered during the period for which support is desired. A description of any significant findings since the most recent progress report should be included. The renewal proposal should treat, in reasonable detail, the plans for the next period, contain a cost estimate, and otherwise adhere to these instructions.

(2) NASA may renew an effort either through amendment of an existing contract or by a new award.

(e) **Length.** Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. Few proposals need exceed 15-20 pages. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments is necessary for each copy of the proposal. As proposals are not returned, avoid use of "one-of-a-kind" attachments.

(f) **Joint Proposals**.

(1) Where multiple organizations are involved, the proposal may be submitted by only one of them. It should clearly describe the role to be played by the other organizations and indicate the legal and managerial arrangements contemplated. In other instances, simultaneous submission of related proposals from each organization might be appropriate, in which case parallel awards would be made.

(2) Where a project of a cooperative nature with NASA is contemplated, describe the contributions expected from any participating NASA investigator and agency facilities or equipment which may be required. The proposal must be confined only to that which the proposing organization can commit itself. "Joint" proposals which specify the internal

arrangements NASA will actually make are not acceptable as a means of establishing an agency commitment.

(g) **Late Proposals**. A proposal or modification received after the date or dates specified in an NRA may be considered if doing so is in the best interests of the Government.

(h) **Withdrawal.** Proposals may be withdrawn by the proposer at any time before award. Offerors are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances which dictate termination of evaluation.

(i) **Evaluation Factors**

(1) Unless otherwise specified in the NRA, the principal elements (of approximately equal weight) considered in evaluating a proposal are its relevance to NASA's objectives, intrinsic merit, and cost.

(2) Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission.

(3) Evaluation of its intrinsic merit includes the consideration of the following factors of equal importance:

(i) Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

(ii) Offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.

(iv) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

(4) Evaluation of the cost of a proposed effort may include the realism and reasonableness of the proposed cost and available funds.

(j) **Evaluation Techniques**. Selection decisions will be made following peer and/or scientific review of the proposals. Several evaluation techniques are regularly used within NASA. In all cases proposals are subject to scientific review by discipline specialists in the area of the proposal. Some proposals are reviewed entirely in-house, others are evaluated by a combination of in-house and selected external reviewers, while yet others are subject to the full external peer review technique (with due regard for conflict-of-interest and protection of proposal information), such as by mail or through assembled panels. The final decisions are made by a NASA selecting official. A proposal which is scientifically and programmatically meritorious, but not selected for award during its initial review, may be included in subsequent reviews unless the proposer requests otherwise.

(k) **Selection for Award**.

(1) When a proposal is not selected for award, the proposer will be notified. NASA will explain generally why the proposal was not selected. Proposers desiring additional information may contact the selecting official who will arrange a debriefing.

(2) When a proposal is selected for award, negotiation and award will be handled by the

procurement office in the funding installation. The proposal is used as the basis for negotiation. The contracting officer may request certain business data and may forward a model award instrument and other information pertinent to negotiation.

(l) **Cancellation of NRA**. NASA reserves the right to make no awards under this NRA and to cancel this NRA. NASA assumes no liability for canceling the NRA or for anyone's failure to receive actual notice of cancellation.

APPENDIX D

GUIDELINES FOR FOREIGN PARTICIPATION

NASA accepts proposals from entities located outside the U.S. in response to this NRA. Proposals from non-U.S. entities should not include a cost plan. Non-U.S. proposals, and U.S. Proposals that include non-U.S. participation, must be endorsed by the respective government agency or funding/sponsoring institution in the country from which the non-U.S. participant is proposing. Such endorsement should indicate the following points: (1) The proposal merits careful consideration by NASA, and (2) If the proposal is selected, sufficient funds will be made available by the sponsoring foreign agency to undertake the activity as proposed.

Proposals, along with the requested number of copies and Letter of Endorsement must be forwarded to NASA in time to arrive before the deadline established for this NRA. In addition, one copy of each of these documents should be sent to:

NASA Headquarters
Office of External Relations
Earth Science Division
Mail Code IY
Washington, DC 20546
USA

Any materials sent by courier or express mail (e.g., Federal Express) should be sent to:

NASA Headquarters
Office of External Relations
Earth Science Division
Mail Code IY
300 E Street, SW
Washington, DC 20024-3210

All proposals must be typewritten in English. All non-U.S. proposals will undergo the same evaluation and selection process as those originating in the U.S. Non-U.S. proposals and U.S. Proposals that include non-U.S. participation, must follow all other guidelines and requirements described in this NRA. Sponsoring non-U.S. agencies may, in exceptional situations, forward a proposal without endorsement to the above address, if review and endorsement are not possible before the announced closing date. In such cases, however, NASA's Earth Science Division of the Office of External Relations should be advised when a decision on the endorsement is to be expected.

Successful and unsuccessful proposers will be contacted directly by the NASA Program Office coordinating the NRA. Copies of these letters will be sent to the sponsoring government agency.

APPENDIX E

EXAMPLES FORMS FOR PROPOSAL COVER PAGE, REQUIRED DECLARATIONS, AND BUDGET SUMMARY

EO-1 EVALUATION AND VALIDATION: NRA-99-0ES-01
Proposal Cover Sheet with Certifications

Title: _____

Principal Investigator Name:_____

Department:_____

Institution: _____

Street/PO Box: _____

City: _____ State: _____ Zip: _____

Country: _____ E-mail: _____

Telephone: _____ Fax: _____

Co-Investigators:

Name	Institution	Telephone	Electronic Mail
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Category Proposing Under: _____
(Category choices: A. Landsat Data Continuity, B. Hyperspectral Applications, C. Calibration)

Budget (U.S. proposal only):

1st Yr.: _____ 2nd Yr.: _____ (3rd Yr.: _____)
(NOTE: For proposals under categories A & C, only 1- or 2-year budgets may be requested; for proposals under category B, 1-, 2- or 3-year budgets may be requested)

Requested Start Date: _____ Requested Duration: _____

EO-1 EVALUATION AND VALIDATION: NRA-99-0ES-01
Proposal Cover Sheet with Certifications (cont.)

Certification of Compliance with Applicable Executive Orders and U.S. Code

By submitting the proposal identified in this *Cover Sheet/Proposal Summary* in response to NRA-99-OES-01, the Authorizing Official of the proposing institution (or the individual proposer if there is no proposing institution) as identified below:

- certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
- agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
- confirms compliance with all provisions, rules, and stipulations set forth in the three Certifications contained in this NRA [namely, (i) *Certification Regarding Debarment, Suspension, and Other Responsibility Matters Primary Cover Transactions*, (ii) *Certification Regarding Lobbying*, and (iii) *Certification of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs*].

Willful provision of false information in this proposal and/or its supporting documents, or in reports required under an ensuing award, is a criminal offense (U.S. Code, Title 18, Section 1001).

Title of Authorizing Institutional Official: _____

Signature: _____ Date: _____

Name of Proposing Institution: _____

Telephone: _____ E-mail: _____ Facsimile: _____

CERTIFICATIONS CITED ON PROPOSAL COVERAGE PAGE –- REFERENCE INFORMATION

Certification of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs

The *(Institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called "Applicant ")* hereby agrees that it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), Title IX of the Education Amendments of 1962 (20 U.S.C. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and the Age Discrimination Act of 1975 (42 U.S.C. 16101 et seq.), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter called "NASA") issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives federal financial assistance from NASA; and hereby give assurance that it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which the federal financial assistance is extended to it by NASA.

This assurance is given in consideration of and for the purpose of obtaining any and all federal grants, loans, contracts, property, discounts, or other federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for federal financial assistance which were approved before such date. The Applicant recognized and agrees that such federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

NASA FORM 1206

CERTIFICATIONS, DISCLOSURES, AND ASSURANCES
REGARDING LOBBYING AND DEBARMENT & SUSPENSION

1. LOBBYING

As required by Section 1352, Title 31 of the U.S. Code, and implemented at 14 CFR Part 1271, as defined at 14 CFR Subparts 1271.110 and 1260.117, with each submission that initiates agency consideration of such applicant for award of a Federal contract, grant, or cooperative agreement exceeding $ 100,000, the applicant must **certify** that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit a Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

2. GOVERNMENTWIDE DEBARMENT AND SUSPENSION

As required by Executive Order 12549, and implemented at 14 CFR 1260.510, for prospective participants in primary covered transactions, as defined at 14 CFR Subparts 1265.510 and 1260.117—

(1) The prospective primary participant **certifies** to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded by any Federal department or agency.

(b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (l)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

BUDGET SUMMARY

For period from _____ to _____

- Provide a complete Budget Summary for year one and separate estimated for each subsequent year.
- Enter the proposed estimated costs in Column A (Columns B & C for NASA use only).
- Provide as attachments detailed computations of all estimates in each cost category with narratives as required to fully explain each proposed cost. See *Instructions For Budget Summary* on following page for details.

		NASA USE ONLY	
	A	**B**	**C**
1. Direct Labor (salaries, wages, and fringe benefits)	_____	_____	_____
2. Other Direct Costs:			
a. Subcontracts	_____	_____	_____
b. Consultants	_____	_____	_____
c. Equipment	_____	_____	_____
d. Supplies	_____	_____	_____
e. Travel	_____	_____	_____
f. Other	_____	_____	_____
3. Facilities and Administrative Costs	_____	_____	_____
4. Other Applicable Costs:	_____	_____	_____
5. SUBTOTAL--Estimated Costs	_____	_____	_____
6. Less Proposed Cost Sharing (if any)	_____	_____	_____
7. Carryover Funds (if any)			
a. Anticipated amount : _____			
b. Amount used to reduce budget	_____	_____	_____
8. Total Estimated Costs	_____	_____	XXXXXXX
9. APPROVED BUDGET	XXXXXX	XXXXXXX	_____

INSTRUCTIONS FOR BUDGET SUMMARY

1. Direct Labor (salaries, wages, and fringe benefits): Attachments should list the number and titles of personnel, amounts of time to be devoted to the grant, and rates of pay.

2. Other Direct Costs:
    a. Subcontracts: Attachments should describe the work to be subcontracted, estimated amount, recipient (if known), and the reason for subcontracting.
    b. Consultants: Identify consultants to be used, why they are necessary, the time they will spend on the project, and rates of pay (not to exceed the equivalent of the daily rate for Level IV of the Executive Schedule, exclusive of expenses and indirect costs).
    c. Equipment: List separately. Explain the need for items costing more than $5,000. Describe basis for estimated cost. General purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested to be made as a direct charge under this award must include the equipment description, how it will be used in the conduct of the basic research proposed and why it cannot be purchased with indirect funds.
    d. Supplies: Provide general categories of needed supplies, the method of acquisition, and the estimated cost.
    e. Travel: Describe the purpose of the proposed travel in relation to the grant and provide the basis of estimate, including information on destination and number of travelers where known.
    f. Other: Enter the total of direct costs not covered by 2a through 2e. Attach an itemized list explaining the need for each item and the basis for the estimate.

3. Facilities and Administrative (F&A) Costs: Identify F&A cost rate(s) and base(s) as approved by the cognizant Federal agency, including the effective period of the rate. Provide the name, address, and telephone number of the Federal agency official having cognizance. If unapproved rates are used, explain why, and include the computational basis for the indirect expense pool and corresponding allocation base for each rate.

4. Other Applicable Costs: Enter total explaining the need for each item.

5. Subtotal-Estimated Costs: Enter the sum of items 1 through 4.

6. Less Proposed Cost Sharing (if any): Enter any amount proposed. If cost sharing is based on specific cost items, identify each item and amount in an attachment.

7. Carryover Funds (if any): Enter the dollar amount of any funds expected to be available for carryover from the prior budget period. Identify how the funds will be used if they are not used to reduce the budget. NASA officials will decide whether to use all or part of the anticipated carryover to reduce the budget (not applicable to 2nd-year and subsequent-year budgets submitted for award of a multiple year award).

8. Total Estimated Costs: Enter the total after subtracting items 6 and 7b from item 5.

APPENDIX F

ELECTRONIC ADDRESSES

The URL references listed below are available for on-line access via the following World Wide Web Home Pages:

(1) NASA Earth Science Enterprise Home Page:
http://www.earth.nasa.gov/

(2) New Millennium Program (NMP) Home Page:
http://nmp.jpl.nasa.gov/

(3) EO-1 Home Page:
http://eo1.gsfc.nasa.gov/

(4) Landsat Program Home Page:
http://geo.arc.nasa.gov/sge/landsat/landsat.html

(5) Earth Observing System AM Platform Home Pages:
http://eos-am.gsfc.nasa.gov/
http://eos-am.gsfc.nasa.gov/modis.html
http://eos-am.gsfc.nasa.gov/aster.html

(6) NASA CRSP Home Page:
http://www.crsp.ssc.nasa.gov/intro.htm

(7) USGS Home Page:
http://www.usgs.gov/

(8) USGS EROS Data Center Home Page:
http://edcwww.cr.usgs.gov/

(9) USGS Spectroscopy Lab Home Page:
http://speclab.cr.usgs.gov/

(10) DOI-NASA Hyperspectral Imaging Technology Transfer Project Home Page:
http://biology.usgs.gov/hwsc/

(11) Naval EarthMap Observer (NEMO) Home Page:
http://nemo.nrl.navy.mil

APPENDIX G

INSTRUCTIONS FOR SUBMITTING LETTERS OF INTENT ELECTRONICALLY

All prospective proposers are strongly encouraged to submit a letter of intent in response to this announcement. This will allow us to alert a peer review staff to adequately cover the proposal review process. This letter of intent is available electronically via the Internet at URL: http://www.earth.nasa.gov/loi We urge you to use these electronic letter of intent forms unless you do not have access to the Internet. In that case, we will accept a FAX copy sent to 202-554-3024 with the following information:

- PI and CoI names and addresses, (including Zip + 4);
- Title of proposal;
- Telephone number;
- Fax number;
- Email address; and
- A brief summary of what you plan to propose (Please limit this to no more than 3000 characters).